

Dynamically Downscaled HadGEM2-ES Historical Simulations And Future Projections of North American Monsoon And IAS Rainfall - What Are We Learning From Our Regional Model?

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HEAVY RAINFALL

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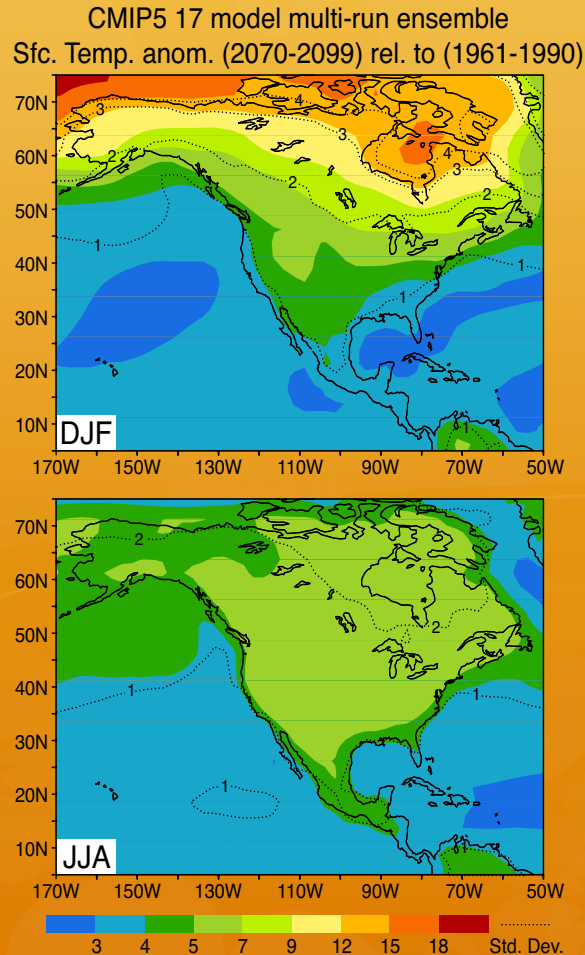
HURRICANES

Alfredo Estrella / AFP

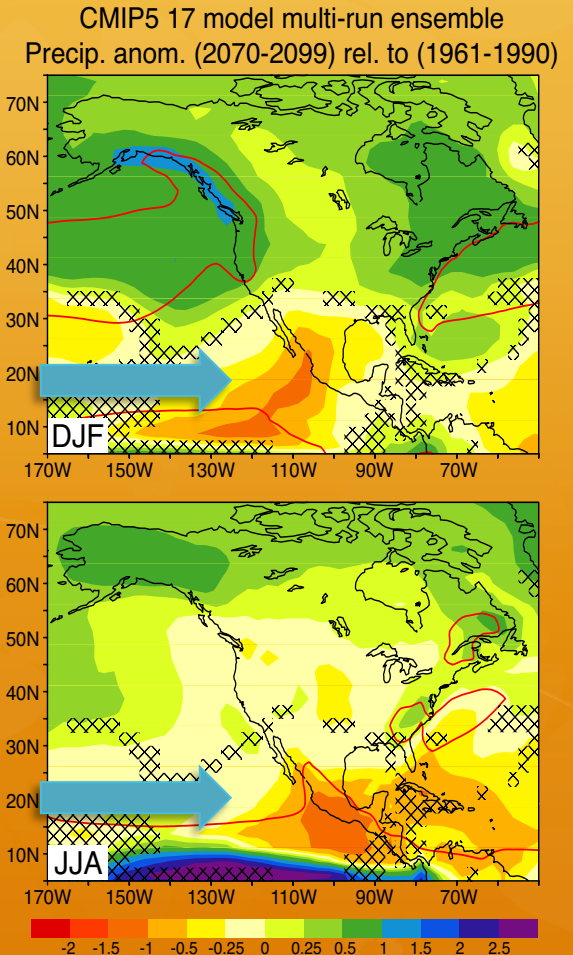
http://www.nbcnews.com/id/44858787/ns/weather/t/hurricane-bears-down-mexican-resort-coast/#.UZms_5VuldJ

Mexico, the East Pacific and the Caribbean have the highest magnitude of projected precipitation changes in North America.

Δ Surface
Temperature
(RCP8.5)



Δ Rainfall
(RCP8.5)



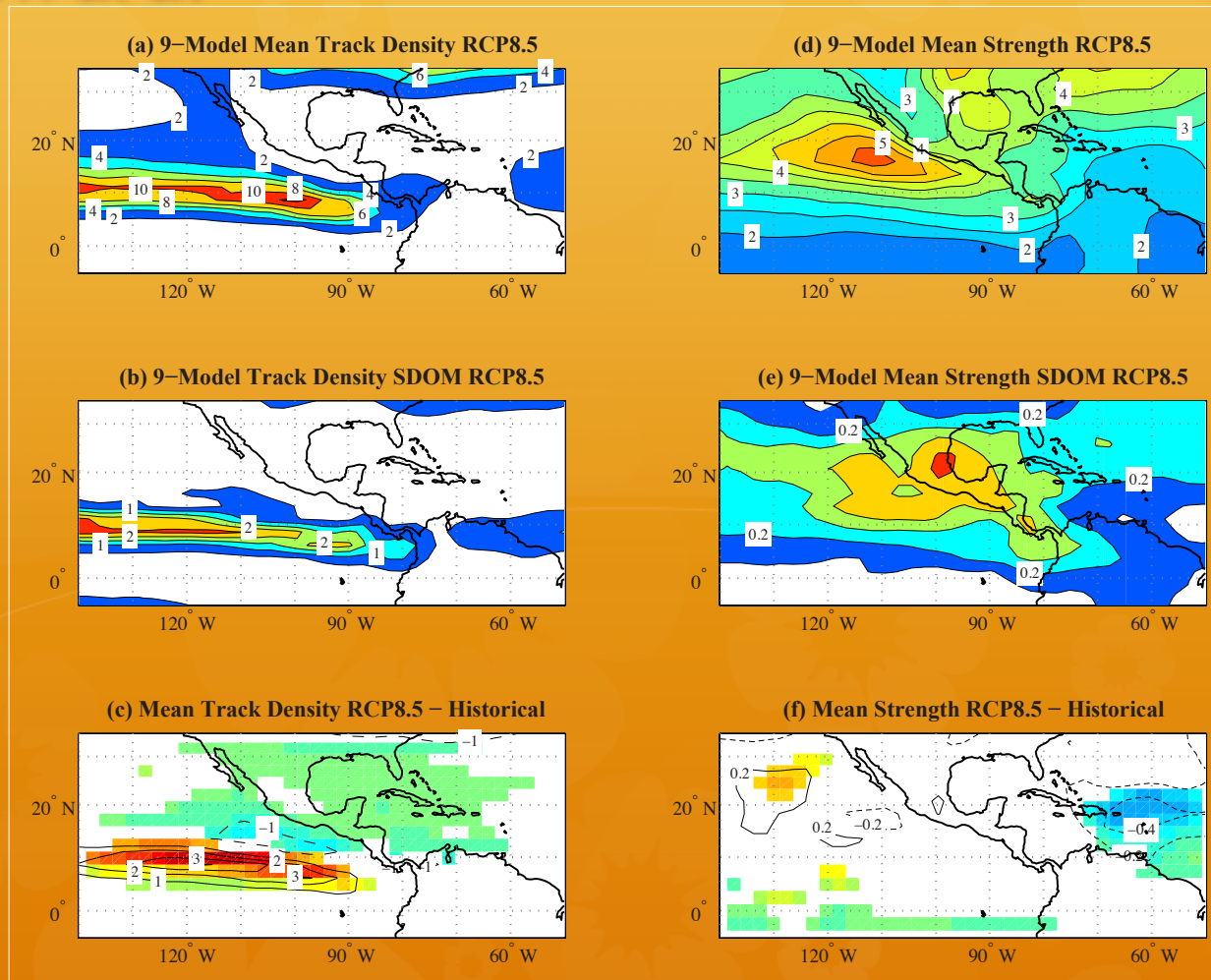
The East Pacific tropical storm track, which impacts rainfall throughout Mexico and the Caribbean, is additionally projected to shift southward.

Track
Density

RCP 8.5

Standard
deviation

Difference
from
Historical

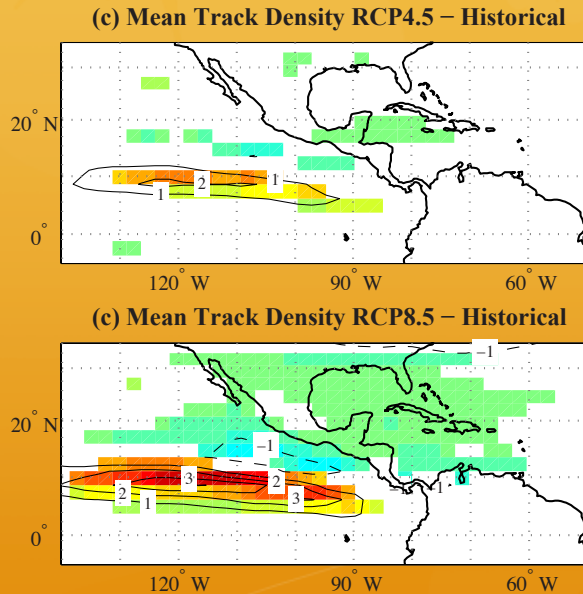


Track
Strength

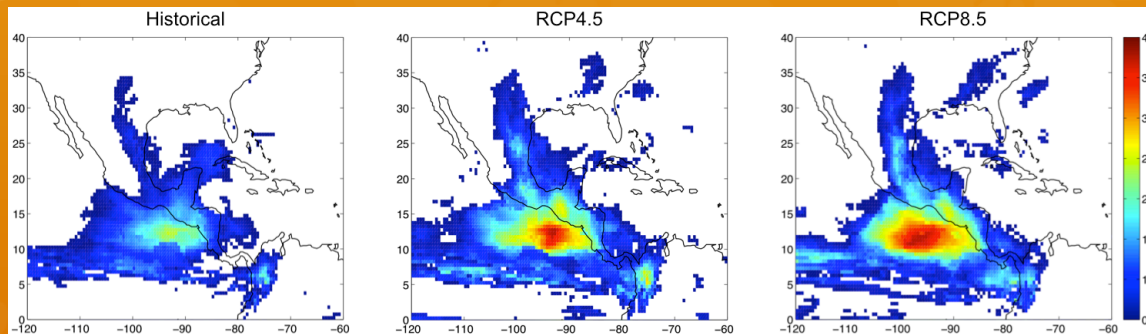
RCP 8.5

The links between the storm track and East Pacific MSD/rainfall need to be explored.

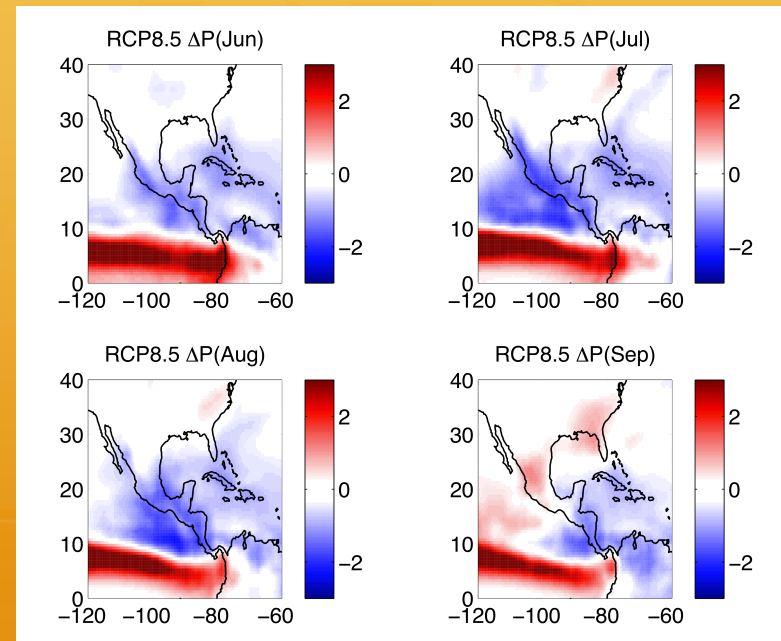
Multimodel Δ TDEN



Multimodel MSD



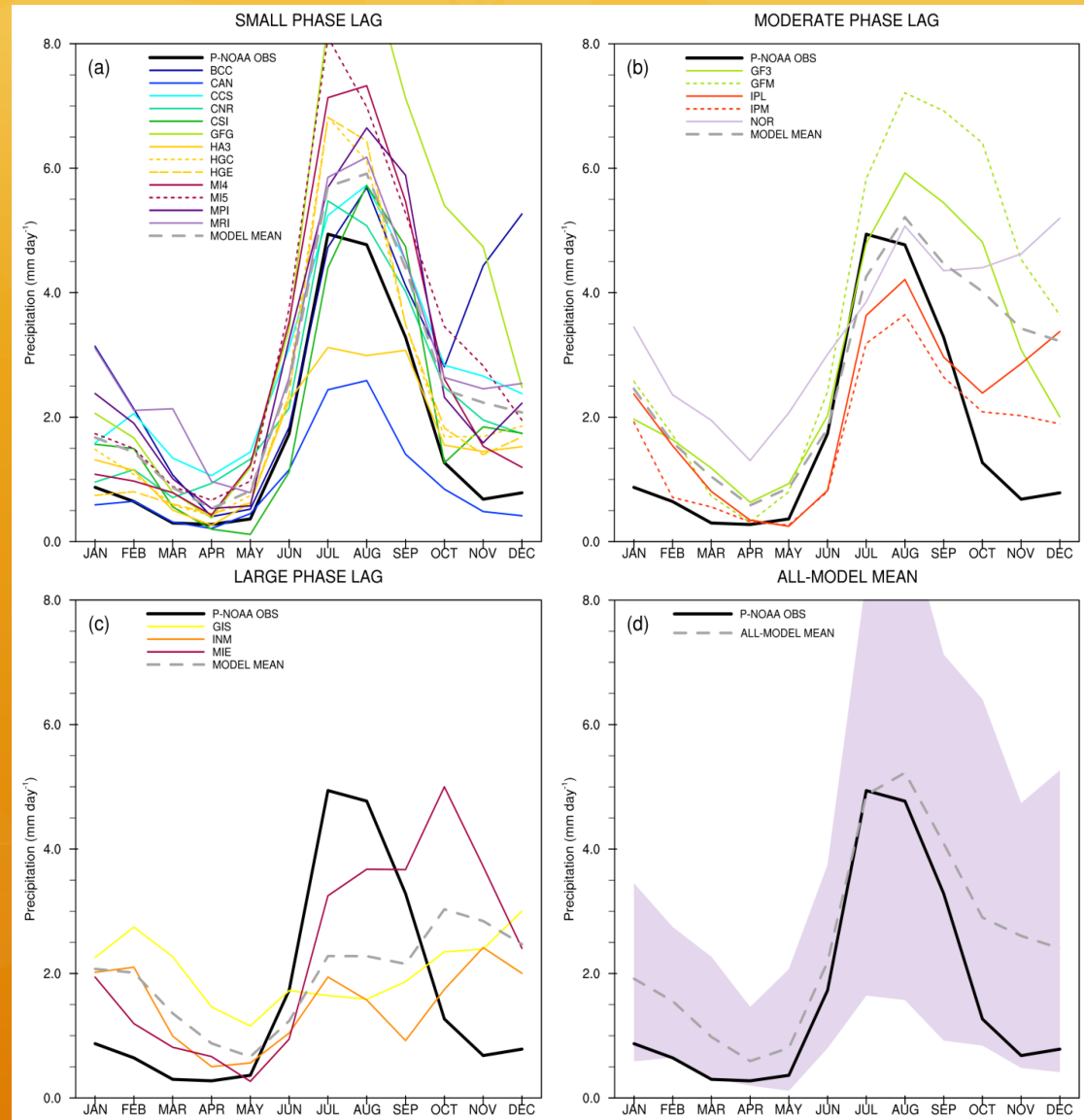
Multimodel Δ P



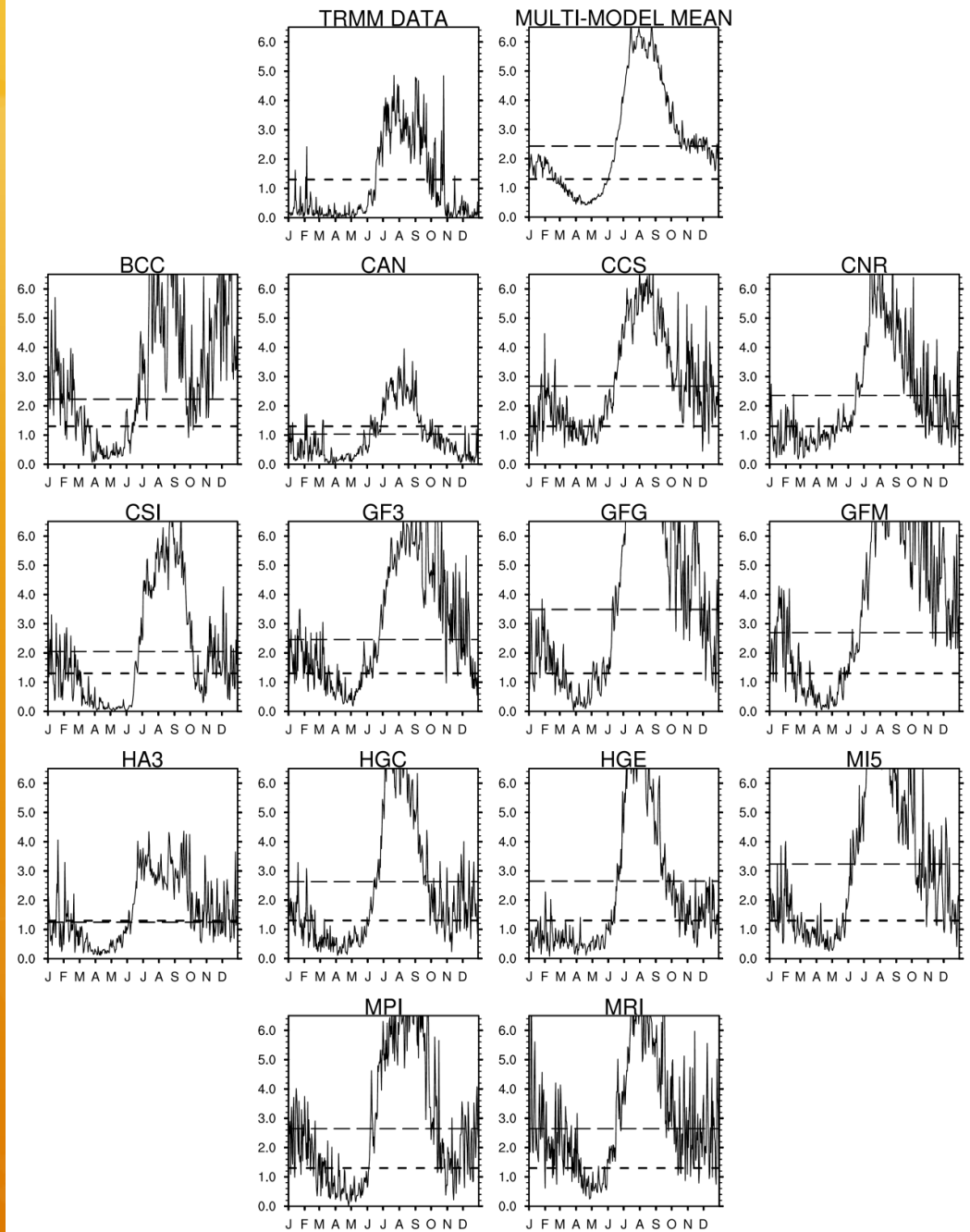
Annual Cycle of Core NAM Monthly Precipitation

Historical Assessment:

- Overestimate peak monsoon rainfall
- Show a recognizable monsoon signal with a clear onset
- Problem terminating the monsoon season
- HadGEM2-ES and MPI are small phase error models



Daily data
analysis: Monsoon
onset and retreat
for 15 models that
had recognizable
monsoon signal in
their annual
cycles.



Monsoon Onset & Retreat For Best Models Based on Daily Data

	Median Onset	Std. Dev. (days)		Median Retreat	Std. Dev (days)
OBS	19 Jun	15.2		28 Sep	8.3

Multi-Model Means

	Mean Median Onset	Mean Lag (days)	Mean Std. Dev. (days)		Mean Median Retreat	Mean Lag (days)	Mean Std. Dev. (days)
Absolute	27 May	-23	14.6		7 Oct	+9	17.9
Model-Relative	6 Jun	-13	16.2		25 Sep	-3	14.6

↑
Early

↖
Base on
3 days

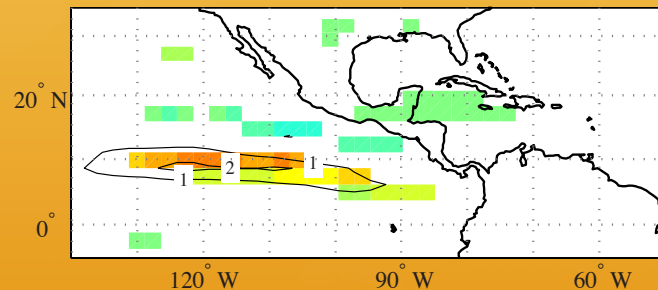
↑
Uncertain

↖
Base on
7 days

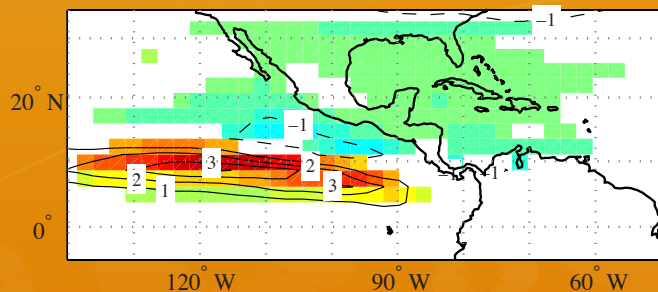
NOAA MAPP project

Multimodel Δ TDEN

(c) Mean Track Density RCP4.5 – Historical



(c) Mean Track Density RCP8.5 – Historical

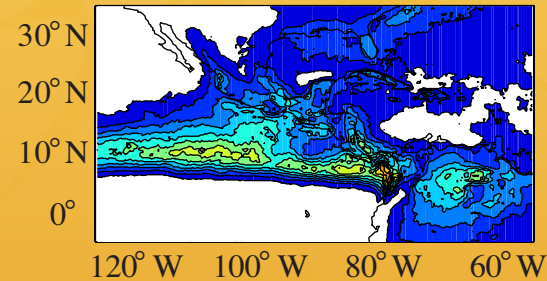


- Downscaled HadGEM2-ES (CMIP5) model for 1977-2003 and 2069-2097 (RCP4.5) @ 35 km
- Starting MPI downscaling for same time periods and for RCP 4.5 and RCP 8.5 @ 35 km.
- Will explore implications of track shift for climatology of convective events in Central America, Mexico and the East Pacific, including the NAM region
- Will revisit forcing mechanisms of East Pacific easterly waves

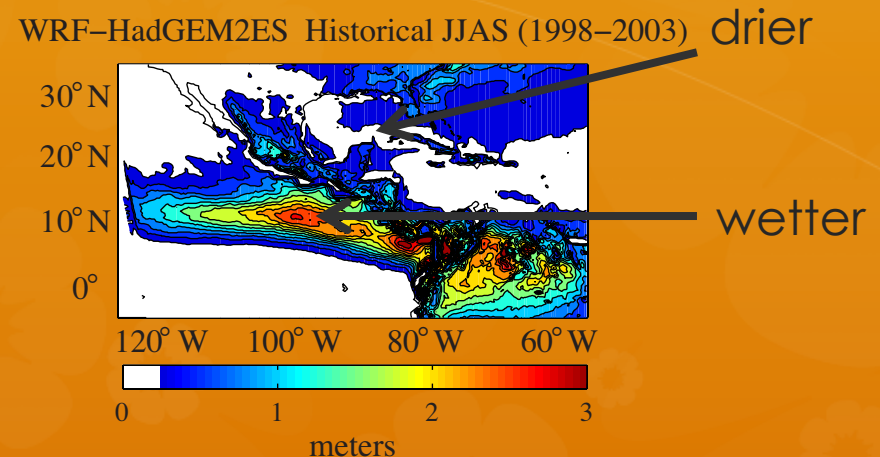
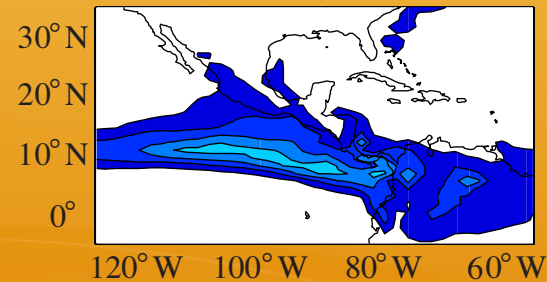
Downscaled precipitation from WRF-Had for JJAS 1998-2003.

- HadGEM2-ES has too little rain everywhere but the main features are present.
- WRF-Had captures rain along the SMO, in northern SA and in ITCZ. Does not capture dry region within Papagayo Jet.
- WRF K-F convective parameterization tends to put too much rain where it is wet and too little where it is drier!

TRMM 3B42 JJAS (1998–2003)

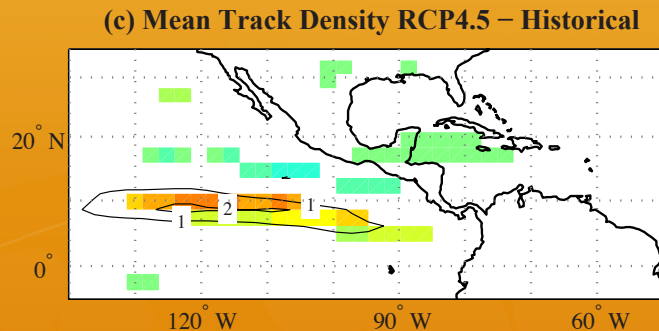


HadGEM2-ES Historical JJAS (1998–2003)

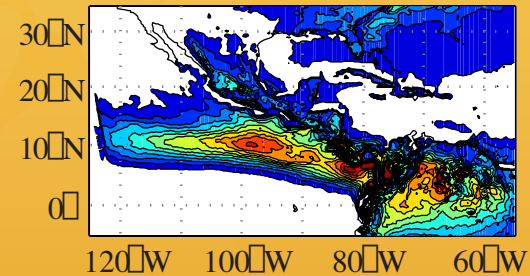


Downscaled precipitation from WRF-Had for JJAS 2069-2097 (RCP4.5).

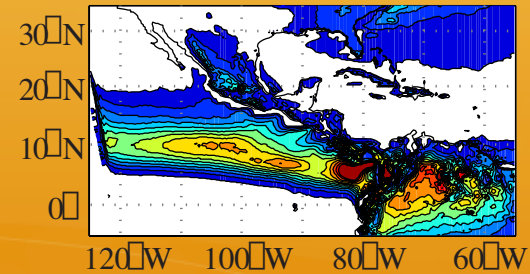
- Shift in rain pattern looks like tropical storm track pattern just as in coarse models!



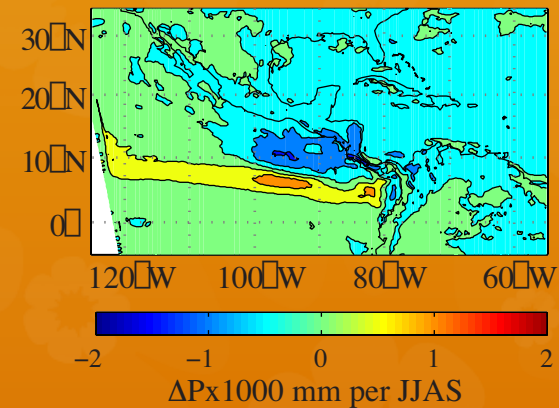
WRF-HadGEM2ES Historical JJAS (1998–2003)



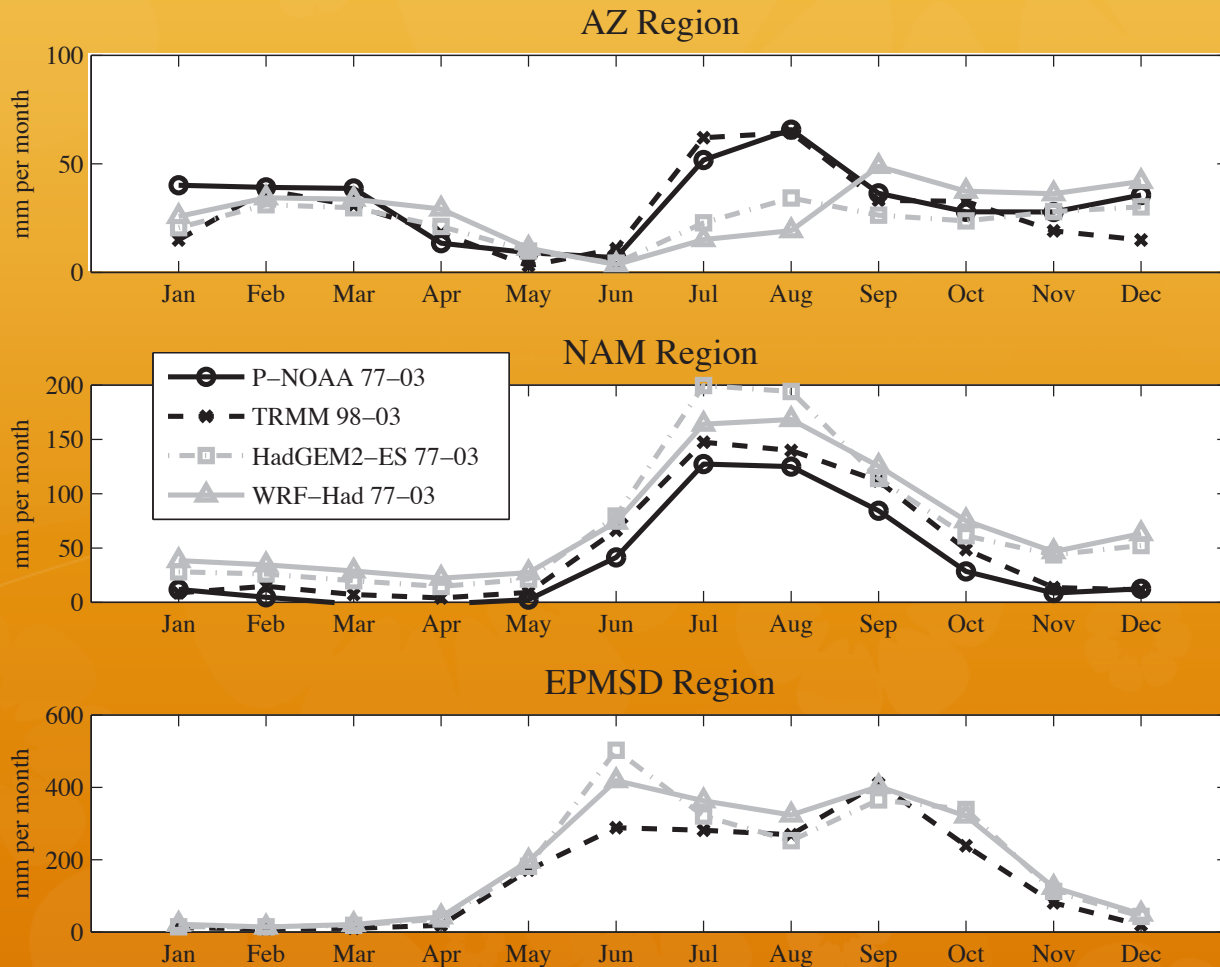
WRF-HadGEM2ES RCP 4.5 JJAS (2069–2097)



WRF-HadGEM2ES RCP 4.5–Historical JJAS

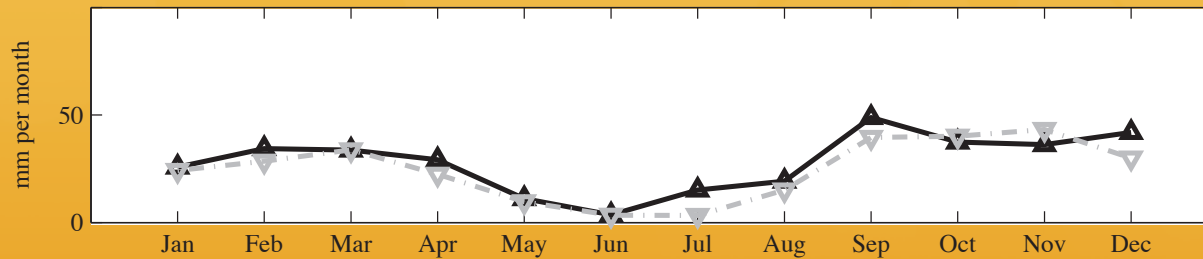


WRF-Had Annual Cycle: Historical Period JJAS 1977-2003

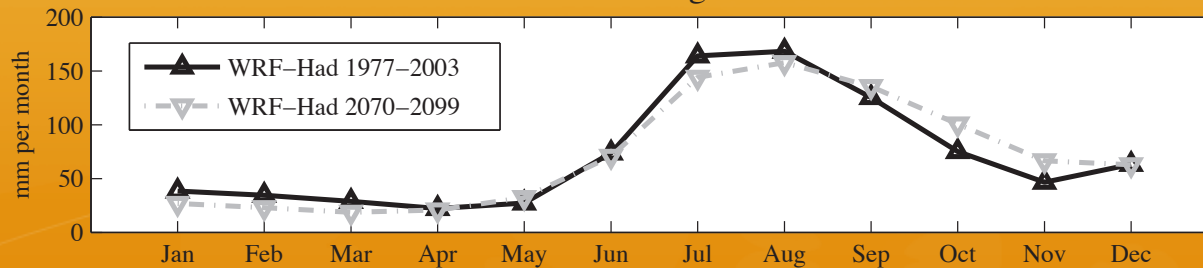


WRF-Had Annual Cycle: Future Period JJAS 2069-2097

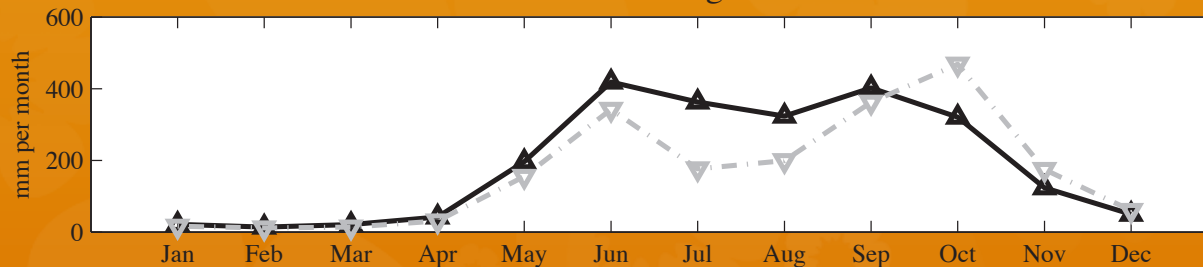
AZ Region



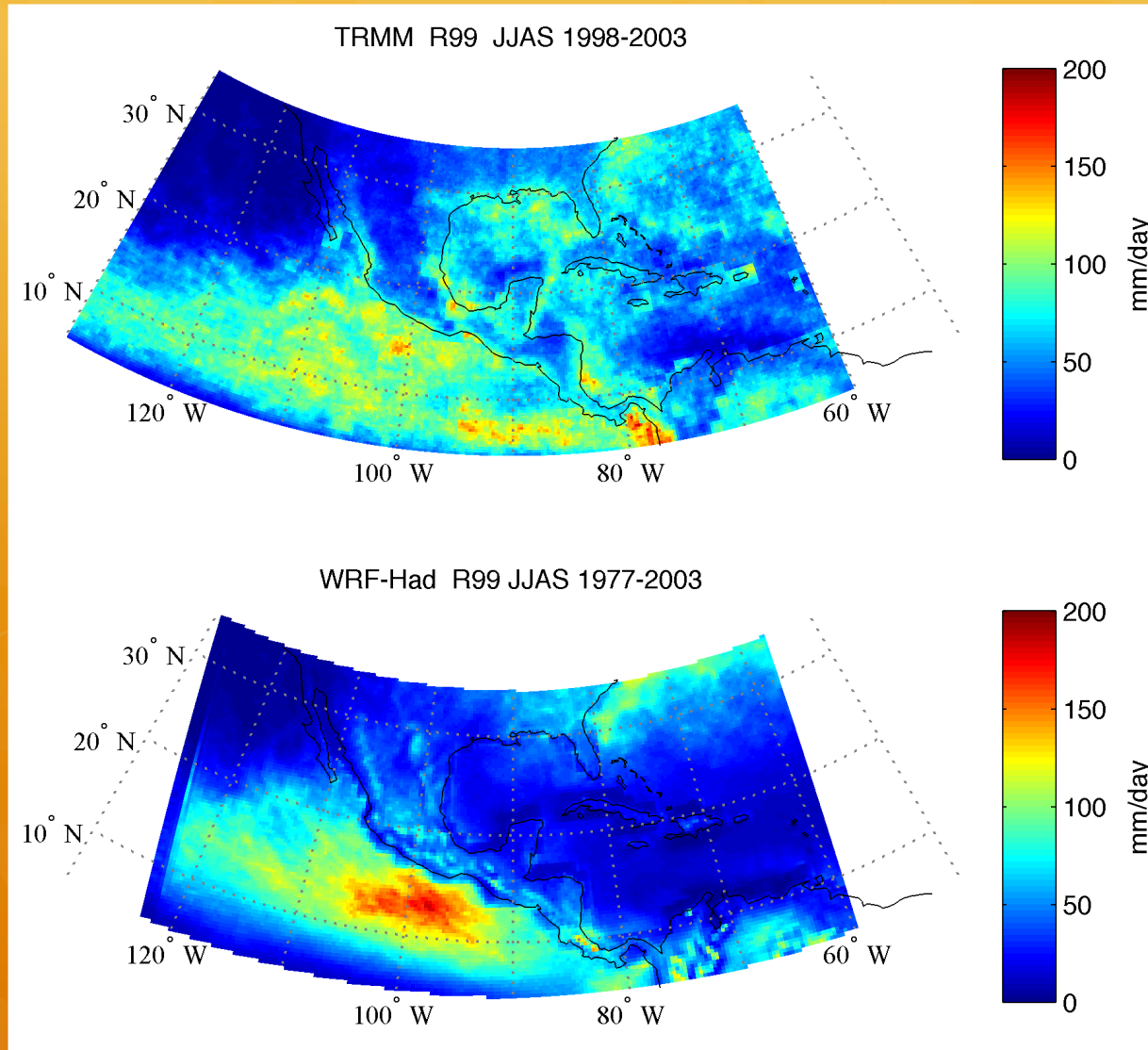
NAM Region



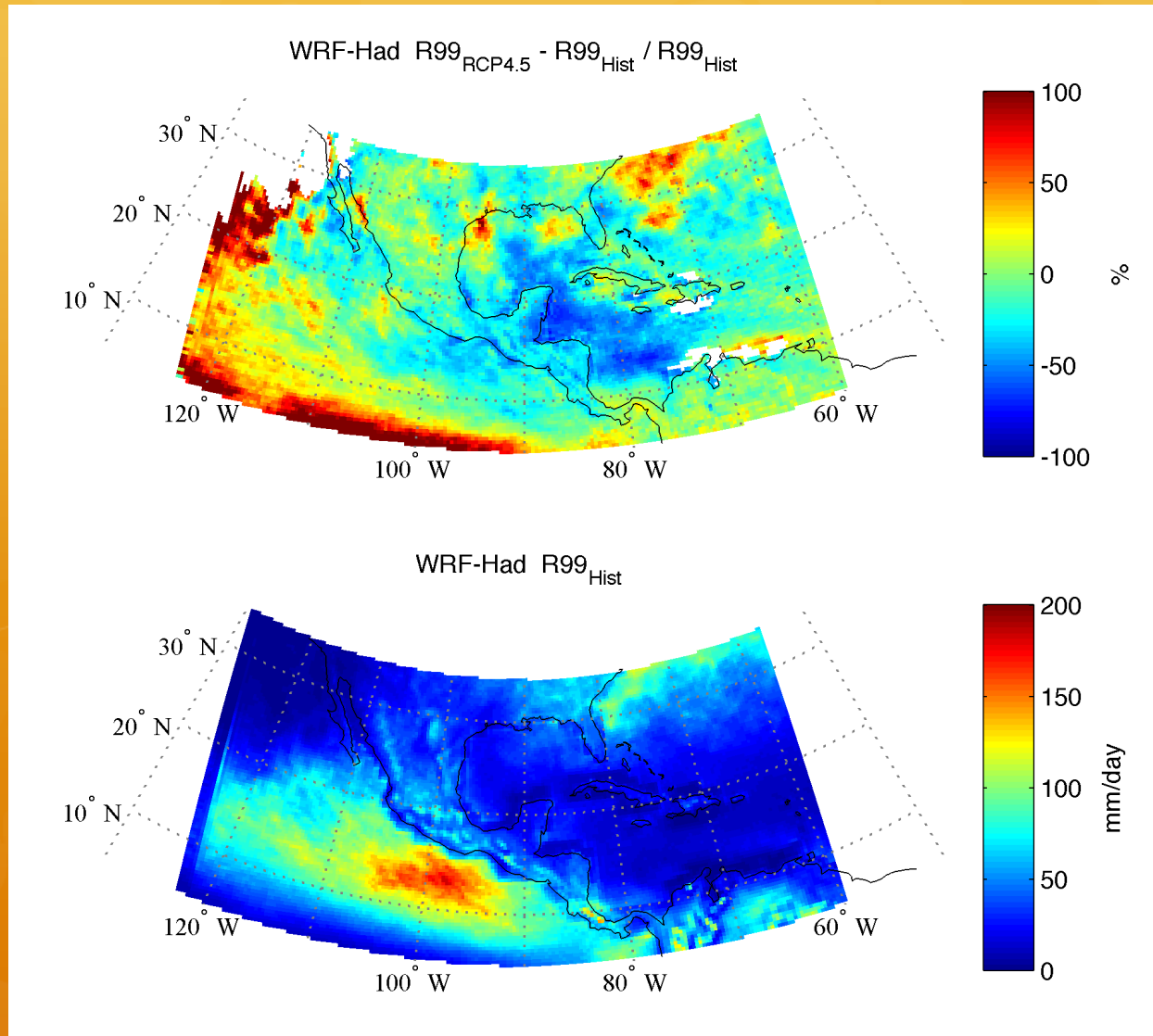
EPMSD Region



WRF-Had 99th Percentile Rain Rates - Historical



WRF-Had 99th Percentile Rain Rates - Future



SUMMARY: WRF-Had Historical

- Original HadGEM2-ES underestimates rainfall throughout the region most likely in part because of the coarse spatial scale.
- WRF-Had overestimates rainfall in the region – common issue for convective parameterizations in regions dominated by convective rainfall.
- WRF-Had Historical JJAS 1977-2003:
 - Annual cycle in 3 regions reflects the coarse scale model – cannot make up for deficiencies in forcing data
 - R99th more regionalized than in TRMM $0.25^{\circ} \times 0.25^{\circ}$ data – need to assess extremes more closely

SUMMARY: WRF-Had RCP 4.5 Future

- WRF-Had mean RCP4.5 JJAS rainfall differences are consistent with southward shift of synoptic disturbance tracks
- WRF-Had RCP 4.5 NAM annual cycle suggests an increase in late season rainfall but this increase is smaller than the late season historical biases (similar to coarse model results)
- WRF-Had RCP 4.5 EPMSD annual cycle shows most significant change consistent with a more intense MSD in this region in the future projections (as shown in Maloney et al. 2003)

SUMMARY: WRF-Had RCP 4.5 Future cont...

- WRF-Had RCP 4.5 R99th JJAS suggests
 - a shift in the location of the storm track
 - a decrease in the magnitude in the western Caribbean
 - an increase along the East Coast of the US, over land areas of Mexico, the Southwest US, areas of the Gulf of Mexico, and northern South America
- Ongoing Work:
 - Examine the AZ, NAM and EPMSD regions more closely for both extreme events and intra-seasonal rainfall statistics
 - Examine links to tropical synoptic wave activity